April 2019
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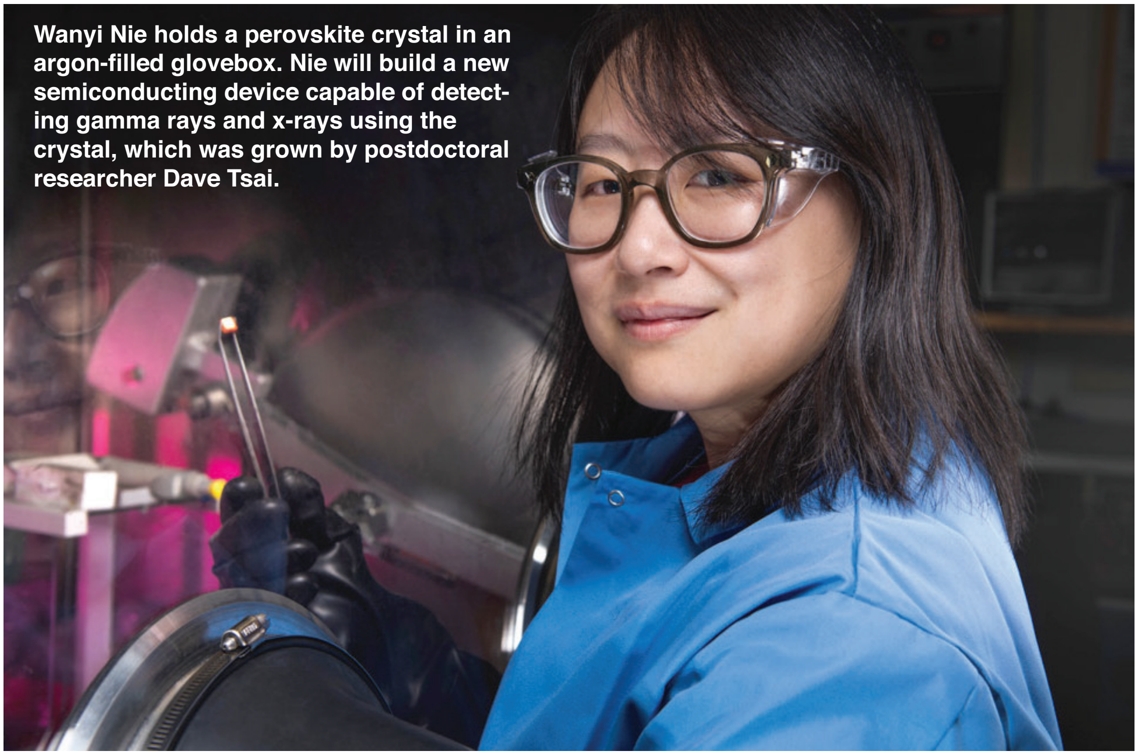
MPA Materials Matter

INSIDE



Wanyi Nie holds a perovskite crystal in an argon-filled glovebox. Nie will build a new semiconducting device capable of detecting gamma rays and x-rays using the crystal, which was grown by postdoctoral researcher Dave Tsai.

Photos by Kevin Sutton, XIT-TSS

Wanyi Nie

Drawing energy from successful scientific partnerships

By Madeline Bolding, ALDPS Communications

Wanyi Nie has an energy about her. A physicist and materials scientist by training, she loves learning about quantum mechanics and wants in on the chemists' conversations, she said, because they are the most fun.

Nie attributes her drive to the fact that she's an early-career researcher. "We have the motivation, passion, and willingness to take the risks to try and push the frontiers of science," she said, describing herself and her fellow junior scientists.

As a member of the Light to Energy team of Materials Synthesis and Integrated Devices (MPA-11), Nie has expanded the definition of what a halide-perovskite semiconductor can do. In 2013, she began studying the crystalline material known for its photovoltaic capabilities—that is, its ability to absorb and transmit energy from light. In what has become a long-term collaboration, theorist Sergei Tretiak (Physics and Chemistry of Materials, T-1) said he first heard about

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> *"Wanyi is a fantastic collaborator: she is readily stepping up to your ground and 'speaks in your language'—clearly postulating the problems her experiment needs help with. On many occasions these were the best examples of theory-experiment collaborations I ever had in the course of my entire research career."*
>
> *Sergei Tretiak, Laboratory Fellow*

Los Alamos NATIONAL LABORATORY EST. 1943

From Rick's desk

We are nearly halfway through FY19, and our transition to Triad has been remarkably smooth. MPA continues to hire outstanding staff, develop new capabilities, and increase our funding portfolio across multiple programs.

We are very proud of our new MPA staff. This year alone, MPA will hire more than 20 new employees, which is more than double our annual average based on the previous five years. Our early-career scientists continue to do very well as we received two Laboratory Directed Research and Development (LDRD) early-career awards and five of our early-career scientists have submitted pre-proposals for Basic Energy Sciences (BES) early-career projects. MPA typically hires 20 postdocs a year, and this year we expect that number to be even higher. We are extremely proud of the contributions from all of our postdocs, particularly our new Oppenheimer Distinguished Postdoctoral Fellow in MPA-11 (please see the article on Dave Tsai, on page 5).

“Thanks to the outstanding research from our scientists, the overall funding in MPA continues to increase...”

Our National Science Foundation (NSF) contract for the National High Magnetic Field Laboratory was renewed last year for an additional five years. During the first week of February, we performed multiple experiments at 86 tesla and higher after a several-months-long break for maintenance, ensuring the long-term viability of the generator as a flagship capability for the Pulsed Field Facility. We are in the process of modernizing the electrical system for the generator as we push our capabilities at the magnet lab to even higher magnetic fields. The NSF has released a call for midscale proposals to bridge the gap between major research instrumentation and construction for equipment and facilities. Our staff are responding to this call in collaboration with Florida State University, and we remain hopeful that this will result in additional funding for LANL and our partners in Florida.

Support from BES is stronger than ever. The Center for Integrated Nanotechnologies (CINT) received funding for two new proposals in quantum information sciences and was awarded CD-0 for its proposal to recapitalize our nation's nanocenters. If successful, this could result in roughly $12M for CINT in the next five years. In addition, MPA-CMMS received a new field work proposal late last fiscal year. There are also exciting changes in the BES leadership at Los Alamos, as MPA's Michael Hundley was recently named the new point-of-contact for the BES materials science and engineering portfolio. As many know, Mike is the group leader of our experimental condensed matter group and has extensive experience with BES.

Thanks to the outstanding research from our scientists, the overall funding in MPA continues to increase, with roughly 5% growth in BES, 10% growth in strategic partnerships such as the NSF, 5% growth in LDRD, and significant growth in our global security and nuclear weapons portfolios. The call for LDRD pre-proposals was recently released, and we are excited about the creative ideas and collaborative spirit of our MPA scientists. This year we anticipate a 40% increase in LDRD pre-proposals with MPA-listed principal investigator or coinvestigator.

It is a pleasure to be associated with MPA. Thank you for your continued support, contributions, and dedication.

MPA Deputy Division Leader Rick Martineau

From Ross's desk

While taking notes on the snowpack and contemplating my latest deadline, I realized that my reluctance at being on the hook for this issue's "From the desk" stems from my personal aversion to spending any significant period of time at my desk. This is not just because of the amazing snow we had this winter but because I'm most at home in the lab (when not playing in the snow). For instance, when proposing to design a 120-tesla magnet system, in response to the National Science Foundation midscale instrumentation call this spring, my clearest thoughts on distilling the wide range of high-field science into succinct motivation were whilst interacting with my colleagues in the lab.

So why am I most at home in the lab? To me, nothing is more fulfilling than performing a challenging experiment and seeing a particularly beautiful data set for the first time. I hope I never lose the thrill of plotting the result of the last pulse. This is something that resonates with our freshman summer students from day one and like any addiction gets better with age. This is not only as our understanding of the underlying physics deepens but because of our appreciation of how many steps must go right to get to that point. It is this common appreciation across the Pulsed Field Facility that fuels (what I honestly think is) one of the best research environments.

"My dining room table is not quite as interesting as my snow-pit desk."

Although I often use the lab as a place to procrastinate,* which results in long nights writing (my dining room table is not quite as interesting as my snow-pit desk), this time is integral to my perspective. As I have taken on more leadership responsibilities over the last few years and strive to find a balance between lab work and the occasional avalanche safety course, I recognize that it is the sum of all these experiences that have taught me a lot about the need for an inclusive safety culture.

Every pulsed field experiment is truly "building on the shoulders of giants." The dedication of our support, technical, engineering, and science staff—and occasionally management ;-) —to enabling world-class science depends on this inclusive safety culture. It would be remiss to discuss safety without acknowledging that it is all too easy to knock the LANL integrated work document/integrated work management bureaucracy, but as the famous LANL alumni Tom Lehrer said, "Life is like a sewer; what you get out depends upon what you put into it." I believe the most important part of lab safety is nurturing an honest and inclusive culture, where everyone from our visiting students to our senior researchers has ownership and as a result is inherently responsible for safety. It's much easier to write this sentence than it is to implement. At the Pulsed Field Facility, we pride ourselves on rigorous safety procedures that enable hands-on user experiments in apparatuses designed to operate at potentially lethal currents and voltages and dissipate megajoules of energy moments later. This stems from the recognition that although engineering controls are a crucial part of this protection, they are only as good as the administrative controls we implement. To this end, putting the informal safety education we provide on an equal footing with the science is key—be it in discussion amongst subject matter experts or introducing a student to our research environment. Clearly understanding the hazards and the logic of all safety procedures is vital to everyone's ongoing engagement.

There are many analogies I can draw between my leadership role at the mag lab and patrolling Pajarito Mountain that have a similar theme to the soft skills that enable ownership of a safety culture, but to conclude, I would like to touch upon complacency. Although avalanche control work, such as my pit to assess the stability of the snowpack, is a very small fraction of patrolling Pajarito Mountain, I had a firsthand reminder of what I take for granted when the top pitch of Sidewinder slid on me whilst we were opening the mountain this season.

On that note I urge all of you that are still reading to take a fresh look at the hazards we work around every day, especially when the excitement of a new data set, or fresh powder turns, clouds our vision.

National High Magnetic Field Laboratory-Pulsed Field Facility
Deputy Director Ross McDonald

*** The importance of procrastination as part of the creative process is a fascinating topic in its own right; however the comedian John Cleese has spoken to the value of mulling over a problem to the extreme far more eloquently than I could attempt; so I refer all you serial procrastinators to his discussions online.**

Nie cont.

Nie from a colleague, who said she had a "magic touch" that could boost a solar cell from 3% to 6% efficiency. "I joked about what would happen if she started from a 10% solar cell, but then, less than one year after starting literally from scratch in the unfamiliar world of organic-inorganic perovskite materials, Wanyi fabricated solar cells with 18% efficiency," he said.

The small-team collaboration of Tretiak, Nie, and her postdoctoral researcher Hsinhan (Dave) Tsai has proved fruitful, producing startling results and earning publications in journals such as *Nature* and *Science*.

"Wanyi is a fantastic collaborator: she is readily stepping up to your ground and 'speaks in your language'—clearly postulating the problems her experiment needs help with," Tretiak said. "On many occasions these were the best examples of theory-experiment collaborations I ever had in the course of my entire research career."

Nie said the team's strength is its ability to make high-quality perovskites with well-defined crystal orientation. Without this, they could only hypothesize about how the chemistry of a perovskite may lead to new properties. A high-quality crystal structure, however, allows them to isolate the way the chemistry affects the crystal's atomic-level structure, which eventually leads to new physical properties.

Because of this focus on structure, the group has discovered that perovskites can have a myriad of properties. The crystals are not only sensitive to light, but also to magnetic fields, x-rays, and gamma rays: all valuable inputs for detectors or information storage. Each perovskite also has certain outputs like light or electricity.

Nie uses her understanding of the unique qualities of each perovskite to imagine and produce new devices. Some have conceptually straightforward applications, like inexpensive light-emitting diodes. However, that's not enough for Nie.

Wanyi Nie holds a gamma-ray detector that she's made using a perovskite (in orange) that acts as a semiconductor when sandwiched between gold and silver electrical contacts.

One of her goals is to produce perovskite detectors that nondestructively observe a variety of signals. Most detectors absorb, and therefore destroy, the signal they are designed to recognize. Nie plans to use her knowledge of perovskite inputs to measure the secondary effect of a signal, leaving the primary intact. Such an advance could benefit applications such as surgical procedures and cancer therapy. Other applications she envisions include an x-ray camera enabled by inexpensive and highly sensitive crystals (please see below for "Wanyi Nie's favorite experiment") and low-energy-consuming information storage and more robust encryption technology using the team's magnetically sensitive perovskites.

Nie said she believes her ideas are within reach at a scientific institution such as Los Alamos, where as a member of a thriving, complex, interdisciplinary organization she has access to collaborators in a variety of fields. Humbled by the scientific history that she joins at Los Alamos, Nie said she is grateful for her collaborators and emphasizes that all young staff need help to continue to grow.

"We don't have extensive networks of collaborators that senior scientists may have," she said. "We want to find places to share our science, we want to meet your colleagues who study things we haven't thought of, and overall we want opportunities to grow."

Wanyi Nie's favorite experiment

What: Testing one of our high-efficiency photovoltaic perovskites for sensitivity to x-rays.

Why: Because it has a heavy element in it, the crystal should be sensitive to radiation.

When: 2016-2019

Where: Fabrication lab at Los Alamos National Laboratory and the synchrotron at Argonne National Laboratory

Who: Wanyi Nie, Dave Tsai (Materials Synthesis and Integrated Devices, MPA-11), and Sergei Tretiak (Physics and Chemistry of Materials, T-1)

The "a-ha moment:" Back in 2016, after trying several variations on ways to make two-dimensional perovskite crystalline films, we discovered that hot casting—coating the film at high temperatures—gave us a nice compact film that was a highly efficient semiconductor, outputting 12% power conversion efficiency (photovoltaic) under sunlight. Because our perovskite had a heavy element in it, we knew it should be sensitive to radiation. Now in 2019, we tested its sensitivity to an x-ray beam. We found it had four orders of magnitude sensitivity, which was 100 times higher than silicon commercial detectors.

MPA staff in the news

Tanja Pietraß selected for DOE's Oppenheimer Science and Energy Leadership Program

Tanja Pietraß (Materials Physics and Applications, MPA-DO) has been selected by the National Laboratory Directors' Council to participate in the Oppenheimer Science and Energy Leadership Program. Pietraß represents Los Alamos as 1 of 15 mid-career professionals in this year's cohort of Oppenheimer leaders, each of whom were identified as having great potential to impact the DOE complex, whether at DOE, a national laboratory, academia, or industry. The aim of this training is to create a network of leaders who will have a shared understanding of the challenges that DOE and the national laboratories face and to provide them with a platform for candidly examining these challenges and possible solutions.

Over the next year, Pietraß and members of the cohort will travel to many of DOE's national labs and to Washington D.C. to meet with research leaders and federal policymakers. They may also visit industry partners and meet with corporate leaders to learn how the DOE complex fits within the broader research environment. Further, the group will participate in workshops designed to help them learn about the breadth and depth of the national labs system, develop leadership skills, and learn effective ways of creating change within the DOE system.

The participants and the program reflect the diverse roles and interests within the DOE complex. The participants come from a variety of backgrounds, including technical group leaders, division directors, a deputy general counsel, and a facilities and operations director. They will be discussing all of DOE's mission interests, spanning basic science, energy, nuclear security, and environmental remediation.

Pietraß's background in academic and programmatic work is well suited for both the mission-focused and basic science aspects of DOE goals. At Los Alamos, she serves as MPA division leader. Before joining the Lab in 2016, she worked as director of Chemical Sciences, Geosciences, and Biosciences at DOE. She has experience as a deputy division leader at the National Science Foundation and as a professor at New Mexico Tech.

The leadership program, now in its third year, is named after J. Robert Oppenheimer, who was tasked with building and overseeing the Manhattan Project as a mid-career scientist. Last year, Materials Science and Technology Division Leader David Teter (Materials Science & Technology, MST-DO) represented Los Alamos in the 2018 cohort.

Technical contact: Tanja Pietraß

Hsinhan (Dave) Tsai awarded Oppenheimer Distinguished Postdoctoral Fellowship

Hsinhan (Dave) Tsai (Materials Synthesis and Integrated Devices, MPA-11, and the National High Magnetic Field Laboratory-Pulsed Field Facility, NHMFL-PFF) received a Los Alamos J. Robert Oppenheimer (JRO) Distinguished Postdoctoral Fellowship. Candidates for such fellowships must display "extraordinary ability in scientific research, potential to impact Laboratory programs and/or ability to establish new capabilities, and show clear promise of becoming outstanding leaders."

Tsai earned his PhD in 2018 in materials science and nanoengineering at Rice University, where his thesis was on hybrid perovskite materials for stable optoelectronic applications. In MPA-11, he works with Wanyi Nie on novel structured hybrid perovskites for gamma-ray detection, profiled on the cover of this issue. At the NHMFL-PFF he works with Vivien Zapf on exploring the coupled magnetic electrical properties on hybrid perovskite materials.

Tsai is the recipient of a Materials Research Society Graduate Student Gold Award; an "On the Spot" award from the Laboratory's Chemistry Division for his previous team's work, which was featured on the cover of *Chemical Communications;* and a Los Alamos Distinguished Performance Award for Small Teams for his contribution in using conjugate polymer for sensor applications as a member of the Chemistry Division group. He is lead author on 16 publications in high-impact journals, including *Science, Nature, Advanced Materials, Advanced Energy Materials, Nature Communications,* and *Chemistry of Materials* and has co-authored another 23 articles.

The JRO Fellowship is one of four distinguished fellowships granted by the Laboratory. Named after the Laboratory's first director, it recognizes individuals whose research aligns with the Laboratory's mission. Out of around 400 postdoctoral researchers that the Laboratory employs, approximately 30 receive Postdoctoral Fellow appointments, and only 5 receive a Distinguished Postdoctoral Fellowship.

Technical contact: Hsinhan Tsai

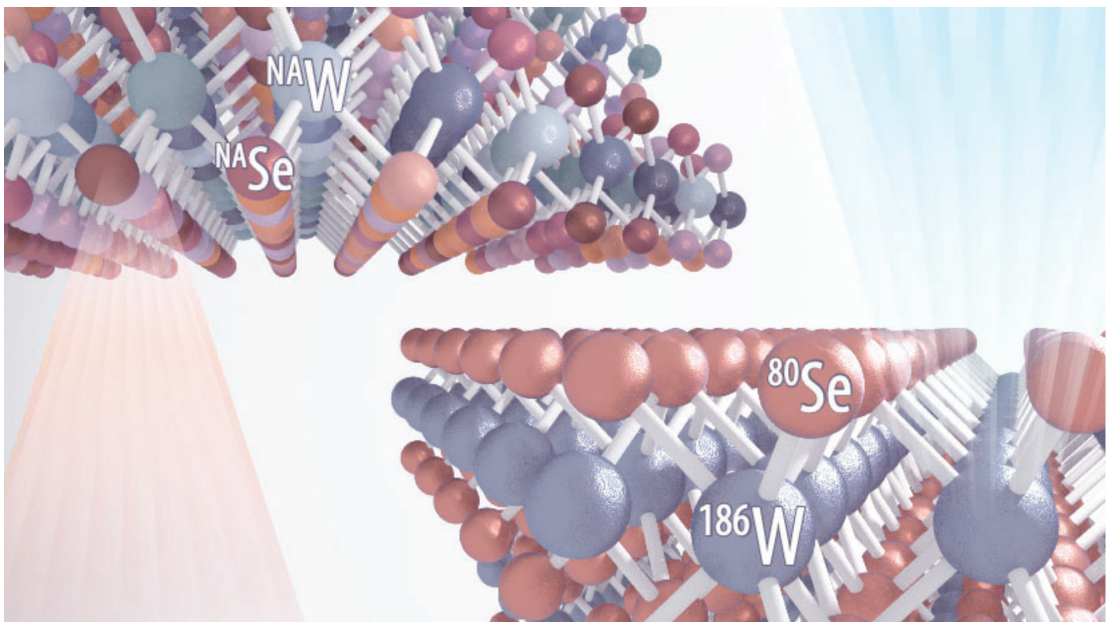
At the 2D scale, isotopic composition has unforeseen effects on light emission

Improvements at the Lab's IBML contribute to first-ever, isotopically pure thin film that counters theoretical knowledge

Compared to bulk materials, atomically thin materials like transition metal dichalcogenides (TMDs) offer size and tunability advantages over traditional materials in developing miniature electronic and optical devices. The two-dimensional TMDs are of particular interest because they have potential applications in energy conversion, electronics, and quantum computing. The properties of these materials can be tuned by external forces, like the application of tensile strain or electric fields, but until recently, nobody had identified a means of intrinsically tuning these materials for optimum photoluminescent or optoelectronic properties. To tune the material without needing external forces, researchers at Los Alamos and their external collaborators instead sought to control the ratios of isotopes within TMDs.

Because different isotopes of an element have the same number of charged particles (electrons and protons), isotopic variations in atomic mass are due to uncharged particles (neutrons) and therefore are not expected to have an effect on electronic band structure or optical emission. In fact, this assumption is so common that theorists do not usually consider isotopic composition when modeling these properties. In this work presented in *Nano Letters*, the team found that isotopic composition had a surprising blue-shift effect on the light emission spectra.

To investigate this, they performed additional studies and proposed a model for the effect. They propose that the effect of isotopic purification on atomic mass leads to a decrease in phonon energies and ultimately a difference in electronic band gap renormalization energy, causing the optical shift.



Artist's rendition depicts the naturally abundant material (left, ^{NA}W ^{NA}Se) with isotopes shown in a variety of colors and the isotopically pure material (right, $^{80}Se^{186}W$) with uniform coloring. The image shows the light emission from each: in comparison with the natural abundance distribution of isotopes, a blue-shift of light emission occurs in the isotopically pure sample.
Image by Daniel Judge (CPA-CAS)

This type of delicate manipulation is recently made easier using Rutherford backscattering spectrometry thanks to improvements to Los Alamos's Ion Beam Materials Laboratory (IBML), which has a tandem accelerator that was upgraded last year for more precise energy tuning, better beam stability control, and improved reliability in overall operations. The new capabilities allowed the team to take precise measurements of the atomic ratios in their samples and characterize the high-quality materials that were essential to testing the effect of isotopic concentration on material behavior.

For the first time, this team was able to grow an isotopically pure and highly uniform TMD material only six atoms thick. They compared this to an otherwise identical film of naturally abundant TMD, which has several different isotopes within the material. Along with characterizing the electronic band structure and vibrational spectra, the team found a surprisingly large effect in light emission that the current state of theory could not explain.

For future experiments, the group plans to further use IBML resources. Besides high precision analysis and implantation capability on the upgraded tandem accelerator, IBML also hosts two low-energy ion implanters that can chemically dope and/or introduce "desired" defects into the isotopically pure sample. The team hypothesizes that creating isotopic defects in the structure will have pronounced effects on the optical and thermal properties of the material.

The work was funded by a National Science Foundation CAREER Award granted to Michael Pettes (Center for Integrated Nanotechnologies, MPA-CINT). Precision thin film characterization was enabled by the Ion Beam Materials Laboratory, operated as a part of Materials Science in Radiation and Dynamics Extremes (MST-8) in the Materials Science and Technology Division. The IBML is classified as a DOE user resource through the Center for Integrated Nanotechnologies (CINT), a DOE nanoscience research

continued on next page

At the 2D scale cont.

center jointly operated by Los Alamos and Sandia national laboratories. Upgrades to the tandem accelerator were funded by the Principal Associate Directorate for Science, Technology, and Engineering capital investment fund and the CINT capability development fund.

The work supports the Laboratory's Energy Security and Fundamental Science mission areas and its Materials for the Future science pillar by identifying the materials properties that enhance performance in energy conversion and allow for the development of novel devices.

Researchers: Wei Wu, Mayra Daniela Morales-Acosta (University of Connecticut), Yongqiang Wang (Materials Science in Radiation and Dynamics Extremes, MST-8, and MPA-CINT), and Michael Pettes (MPA-CINT).

Reference: "Isotope Effect in Bilayer WSe_2," *Nano Letters* 19, 1527–1533 (2019).

Technical contact: Michael Pettes

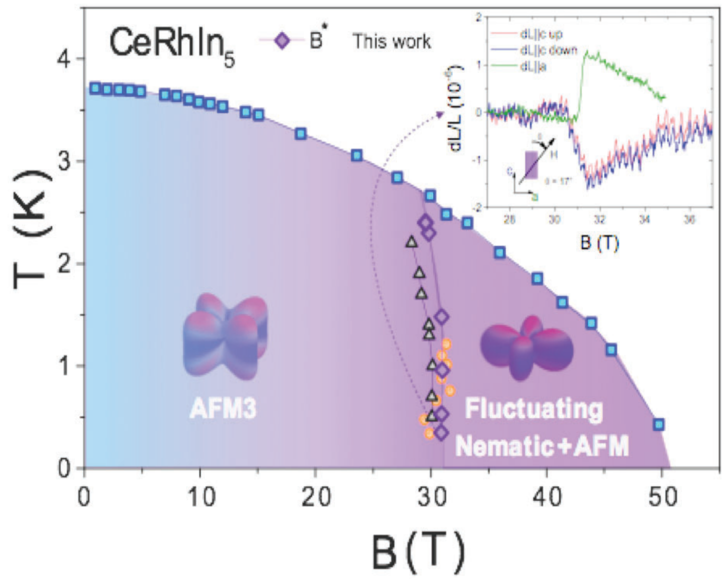
Using high magnetic fields to help define the nematic phase in cerium-based materials

Results aid fundamental and applied understanding of rare-earth-based materials

Using the unique capabilities of the National High Magnetic Field Laboratory-Pulsed Field Facility, MPA researchers and their external collaborators recently found evidence that the nematic phase in $CeRhIn_5$ is electronic in nature but driven by local degrees of freedom.

Understanding the nature of this phase, previously debated, can help explain why similar cerium-based materials can exhibit novel phenomena such as heavy electron masses, unconventional superconductivity, and non-Fermi-liquid behavior at the Fermi surface. $CeRhIn_5$, a prototypical heavy fermion, is particularly suited to this study because the 4*f* electron in cerium is known to hybridize with conduction electrons in many elements, causing destabilization in materials that otherwise are magnetically ordered. The destabilization leads to the emergent phenomena.

Remarkably, $CeRhIn_5$ demonstrates similar behavior in magnetic fields as it does under pressure: the 4*f* electrons couple more strongly with nearby conduction electrons. The team sought to understand this effect and, among other goals, unveil the nature of the high-field *XY* nematic phase. Subjecting the $CeRhIn_5$ samples to very high DC magnetic fields up to 45 tesla, they took high-resolution magnetostriction measurements using both capacitance dilatometry and an optical dilatometry technique that members of their team and others have recently refined. From their measurements,



Magnetic field-temperature phase diagram of $CeRhIn_5$. A change in the Ce *f*-electron ground state gives rise to enhanced hybridization that in turn promotes electronic nematicity.

they identified the bounds of the nematic susceptibility of the material. They also identified pressure and magnetic field parameters in which the Ce 4*f* electrons couple with conduction electrons, thereby explaining the phenomenon in which the electrons are able to couple even in high magnetic fields. Their results suggest that the nematic behavior is of electronic origin and is driven by hybridization.

This work was the result of a collaboration between researchers from Condensed Matter and Magnet Science and the National High Magnetic Field Laboratory, which are internationally recognized leaders in the field of strongly correlated *f*-electron systems and high-field magnetostriction measurements, respectively. A portion of this work was performed at Los Alamos's Pulsed Field Facility, which achieves record magnetic pulses and is a part of the National High Magnetic Field Laboratory, a national user facility and the largest and highest-powered magnet laboratory in the world, funded by the National Science Foundation and the State of Florida.

The work supports the Lab's Energy Security mission area and its Materials for the Future science pillar, including its emergent phenomena theme by understanding how a material's properties contribute to its performance in ways beyond its basic properties. This enables the development of materials with controlled functionality and predictable performance, which is a central vision of the Laboratory's Materials for the Future strategy. The work was funded by the Laboratory Directed Research and Development program and the U.S. DOE Office of Basic Energy Sciences.

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Using high magnetic fields cont.

Researchers: P. F. S. Rosa and S. M. Thomas (Condensed Matter and Magnet Science, MPA-CMMS), F. F. Balakirev (National High Magnetic Field Laboratory-Pulsed Field Facility, NHMFL-PFF), E. D. Bauer (MPA-CMMS), R. M. Fernandes (University of Minnesota), J. D. Thompson and F. Ronning (MPA-CMMS), and M. Jaime (NHMFL-PFF).

Reference: "Enhanced hybridization sets the stage for electronic nematicity in $CeRhIn_5$," *Physical Review Letters* 122, 016402 (2019).

Technical contact: Priscila Rosa

Using radiation damage to enhance ionic transport in a crystalline compound

Technique aids efforts to develop materials with enhanced conductivity for fast ion conducting applications

The goals of clean and efficient energy generation and consumption place demanding cost and performance requirements on replacement technologies. While solid oxide fuel cells are a promising low-carbon replacement technology because of their fuel flexibility and exceptional efficiency, their high operating temperature of 800–1000˚C presents barriers due to cost and durability. Fast ionic conducting materials that could quickly dissipate heat are required to reduce the operating temperature to the target 500–700˚C range.

To aid the development of these advanced functional materials, Los Alamos researchers and their collaborators leveraged Laboratory expertise in thin films and materials characterization to isolate the effect of material disorder on electronic conductivity, improving it by several orders of magnitude.

Conductance is tied to a material's disorder. While previous studies analyzing material disorder induced damage via chemical doping, this new work used radiation as a means to isolate the phenomenon in a single oxide composition. As a result they discovered that disorder alone influences transport in pyrochlore oxides. Their work, which appeared in the *Journal of Materials Chemistry A,* provides a new pathway for tailoring materials with enhanced conductivity for fast ion conducting applications.

The team created a thin film of highly organized material, pyrochlores, and induced defects in the material using the light ion irradiation capabilities of the Ion Beam Materials Laboratory.

The materials were found to exhibit increased disorder with increasing irradiation, although the disorder was non-uniform throughout film depth. They measured the conductance afforded by this added disorder and found a marked increase in conductivity immediately upon introducing small amounts of anti-site disorder into the structure. Inducing less than 2% disorder into the pyrochlore thin film increased conductivity by almost two orders of magnitude at 500˚C and by almost one order of magnitude at 800˚C.

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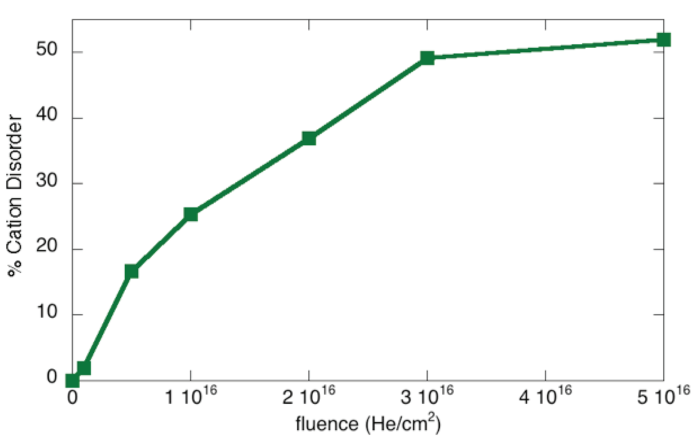

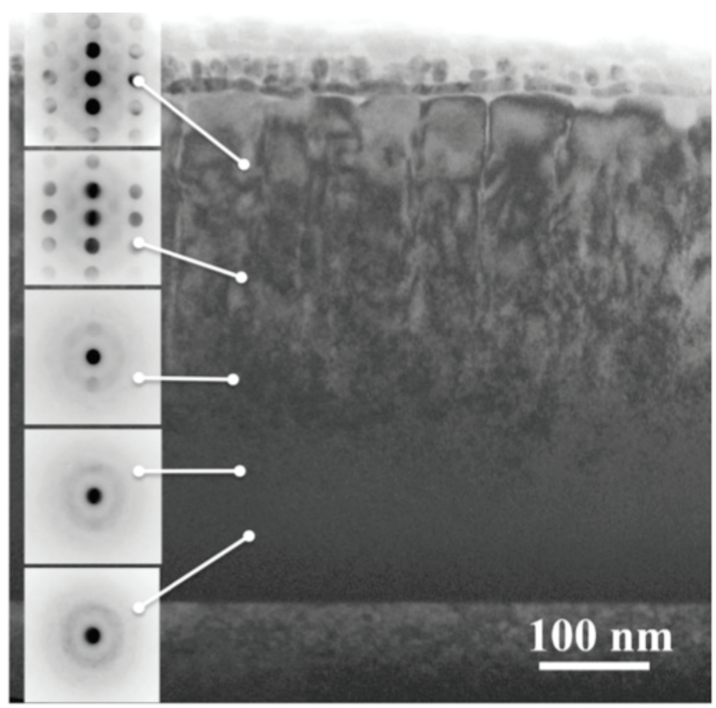

(Left) Cation disorder as determined from x-ray powder diffraction shows a monotonic increase as a function of the level of irradiation, He fluence. (Right) A transmission electron micrograph of a film irradiated at the highest fluence considered in this study, $9x10^{16}$ He/cm^2. Insets show the selected area electron diffraction patterns throughout the film depth between the exposed surface, which retained the ordered pyrochlore structure, and the material interface below, in which the superlattice reflections disappear non-uniformly as the material adopts the defect fluorite structure before all of the crystalline reflections disappear as the material becomes amorphous near the bottom interface.

Using radiation damage cont.

The researchers characterized the point at which the material began to amorphize, identified the maximum level of crystalline anti-site disorder that the material can accommodate, and found that the introduction of the amorphous phase coincided with a further increase in conductivity by roughly another order of magnitude.

This work was supported by the U.S. Department of Energy, Office of Science, Basic Energy Sciences, Materials Sciences and Engineering Division grant number LANLE4BU (LANL Program Manager John Vetrano).

The work supports the Laboratory's Nuclear Energy Security mission area and its Materials for the Future science pillar by understanding the characteristics that allow a material to reach peak performance, thus enabling future products that generate and use energy efficiently. This tailoring of materials with controlled functionality and predictable performance is the core vision of the Lab's materials strategy.

Researchers: Cortney R. Kreller (Materials Synthesis and Integrated Devices, MPA-11), James A. Valdez (Materials Science in Radiation and Dynamics Extremes, MST-8), Terry G. Holesinger (Nuclear Materials Science, MST-16), Jonathan Morgan (University of Sheffield), Yongqiang Wang and Ming Tang (MST-8), Fernando H. Garzon (University of New Mexico), Rangachary Mukundan and Eric L. Brosha (MPA-11), and Blas P. Uberuaga (MST-8).

Reference: "Massively enhanced ionic transport in irradiated crystalline pyrochlore," *Journal of Materials Chemistry A* 7(8), 3917-3923 (2019).

Technical contact: Cortney R. Kreller

Celebrating service

Congratulations to the following MPA Division employees celebrating recent service anniversaries:

Darrell Roybal, NHMFL-PFF	25 years
Christopher Romero, MPA-11	20 years
Dmitry Yarotski, MPA-CINT	20 years
Nan Li, MPA-CINT	10 years

HeadsUP!

Cyclists and drivers: Share the road

Warm weather is here, and many people are bringing their bicycles out of winter storage. Here are some tips on driving safely near bicyclists adapted from the National Highway Traffic Safety Administration.

People riding bicycles have the same rights and responsibilities as people behind the wheel of a vehicle.

- Yield to bicyclists as you would motorists and do not underestimate their speed. This will help avoid turning in front of a bicyclist traveling on the road or sidewalk, often at an intersection or driveway.
- In parking lots, at stop signs, when backing up, or when parking, search your surroundings for other vehicles, including bicycles.
- Drivers turning right on red should look to the right and behind to avoid hitting a bicyclist approaching from the right rear. Stop completely and look left-right-left and behind before turning right on red.
- Obey the speed limit, reduce speed for road conditions and drive defensively to avoid a crash with a cyclist.
- Give cyclists room. Do not pass too closely. Pass bicyclists as you would any other vehicle—when it's safe to move over into an adjacent lane.

MPA Materials Matter

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